Mechelectiv

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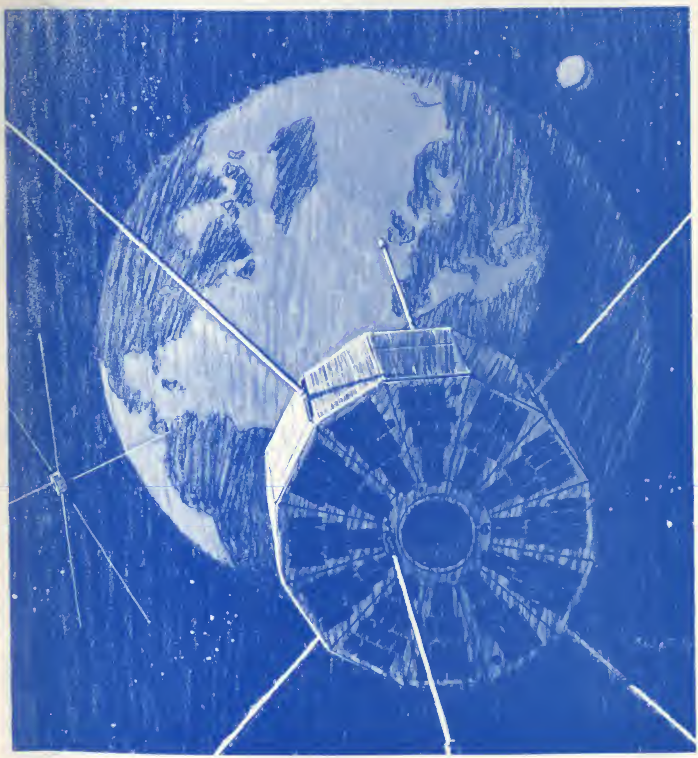
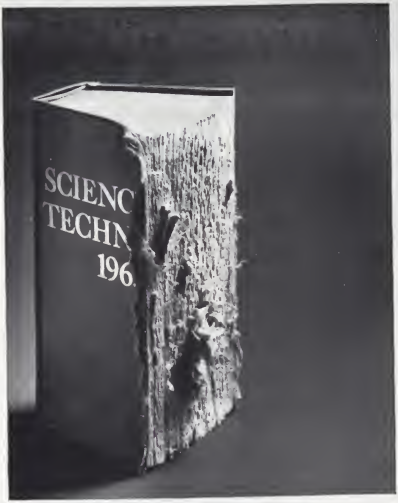


THE GEORGE WASHINGTON UNIVERSITY

OCTOBER 1965



Where will you stand 10 years from today, when half of what you now know becomes obsolete?

Right now you're steeped in the latest technologies. But 10 years from now half of this knowledge will be obsolete. And half of what you will need to know isn't even available today.

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WHY ARE <u>YOU</u> HERE?

Once again, stubble chinned, fuzzy headed (or fuzzy chinned, stubble headed) little GWU engineering students begin the annual attempt to focus their eyes and minds on the pages of equations in front of them. And, as if compelled by the same instinct that makes salmon swim upstream, they fill out the IBM cards, pay their money and trudge up the stairs of Tompkins Hall to begin the strange ritual once again.

Perhaps one of the first questions to slide across their greasy brain pans at these trying times is . . . "Why the ---- am I here at good ol' ivyless GWU School of Engineering, etc., spending more than I would on a girl, to listen to some graduate yoyo mumble to himself about something that doesn't even remotely resemble E*N*G*I*N*E*E*R*I*N*G." The random motion of an elastic pentagonal icosahedron, subject to periodic force inputs in an inhomogeneous magnetic field . . . in spherical coordinates, is one of the last things that might be thought of to arouse the interest of a healthy young man.

So why the ---- <u>do</u> they come back? Getting a good answer would require a complicated random sample of personal reasons, a statistical analysis of the data and a study of the inherent error and inanities of such a project. Since this would mean several years and a government grant, and since this is my seventh crack at the annual ritual, maybe we can get a few chuckles out of my reasons while we're waiting for the forms to be processed.

I believe any engineering student reading these words, has the opportunity to fulfill one of the most awesome destinies the gods ever offered a man. It's possible that a single engineer can hold the power to destroy all signs of civilized life . . . or save and raise the lives of millions of human beings. A single engineer can design a button to push in that supreme moment of temporary insanity . . . or processes to give clean water, ample food ... and time ... to the world.

The choice of the use of this power is a matter between a man and his gods, but the power knowledge, can only be attained by hard work. Though your virtues are "as the stars in the heavens", your IQ in four figures, and your name written in the book of the prophets, the only way to get the knowledge is through study. College is just a set of warming up exercises. The real work comes later; making radios out of solid state theory, bridges out of statistics and engines out of thermodynamics.

Every man who has one, must feed the gnawing ulcer of his ego or be eaten by it. The feeling that his work is important, that his contribution can be seen in the background of team effort, the feeling that his presence is felt on earth and that he left some tracks on his way through; all these are needed if he is to be able to look himself in the eye in the morning and not cut his throat with the razor. I believe the reason the fuzzy chinned students return to the GWU School of Engineering, etc., is to get some palatable food for their personal demons.

So, Young Engineer, study hard, and remember while you're wading through Laplace transforms and tensor analysis that it all does have an application. You're being introduced to a good, basic engineering education. If you don't study hard, your liver will turn to yak butter, your slide rule will warp, your girl will run off with an art major and the troll that lives in the dark pit of the M.E. lab will eat you up. But if you work, you'll be rewarded, with one of the most interesting, self-satisfying of professions ... and you'll be able to sleep at night knowing that you really do have a soul.

mec

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The Mecheleciv

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page

ARTICLES

DEPARTMENTS

COVER

It looks like our Artist has been flying a little too high again.

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YOUR ENGINEERS' COUNCIL

by Bruce Howard

DESCRIPTION

The Engineers' Council is the student governing body for the School of Engineering and Applied Science. It is composed of the following representatives:

Introductory Level	(4)
Intermediate Level	(2)
Advanced Level	(2)
ASCE	(1)
ASME	(1)
IEEE	(1)
Sigma Tau	(1)
Tau Beta Pi	(1)
Theta Tau	(1)
Student Council Rep.	(1)
Engineers' Open House Chairman*	
Davis-Hodgkins House Manager*	
MEA Representative*	
MSE Representative*	

*Appointed by the President of the Council.

The Council is maintained financially by the Engineers' Council Fee paid by each student in the School of Engineering.

FUNCTION

The primary purpose of the Council is to provide liaison between the student body and the Faculty, Administration, and the Student Government of the rest of the University.

Included in this purpose is the important function of serving as a sounding-board for student complaints. If a student has a legitimate complaint about a course, a grade, or a professor he may bring it to the attention of the Council. If upon hearing the complaint, the Council feels that the complaint is legitimate and warrants action, the Council will take what ever action is necessary to solve the problem. The student is guaranteed that he can remain anonymous if he so desires.

ACTIVITIES

The Council sponsors a number of events during the year including the Engineers' Ball, the Annual Christmas Tree Lighting Ceremony in the University Yard, the Engineers' Mixers, and Engineers' Open House, better known as Engineers' Week.

The Engineers' Ball will be held on November 11. An all-out effort is being made by the Council in its planning to make this year's Ball the best ever held. However, the success of the Ball depends almost entirely upon the support given it by the student body. So when the time comes, buy your ticket, go to the Ball, have a few drinks, dance, and watch the crowning of the Engineers' Queen.

The Engineers' Council also sponsors and acts as the directing body for this magazine which is published six times during the school year. The success of Mecheleciv also depends a great deal on student support. Your contributions in the form of articles, news items, and news of coming events would be greatly appreciated.

MEETINGS

The Engineers' Council holds its meetings on the fourth Wednesday of each month in the Dean's Conference Room, Tompkins Hall. Meeting times are posted on the north bulletin board. The meetings are open to the student body.

NEWS FLASH!

"AUTO DRIVEN TO BALTIMORE IN ONE DAY BY G.W. BOYS"

"May 3, 1905--Two George Washington University boys accomplished a feat unparalleled in the history of the automobile. They made the trip to Baltimore in an electric car, taking only fourteen hours.

"Last week Lenard Brown and Charles Edwards broke all existing records for long distance motoring. They started from Washington at eight o'clock in the morning and arrived in Baltimore at ten o'clock the same night. They were received in Baltimore by the mayor and many prominent citizens who hailed the feat as the beginning of a new era.

"After a night's rest, the two heroes prepared their car for shipment back to Washington and returned here by train. They were greeted on their return by the prominent citizens and many of their college friends.

"When asked for comment of their wonderful performance, the boys replied that they thought such trips would soon become a common thing even though they were very draining on the energies of the drivers. In their opinion, the new pneumatic tires are a failure. They had fifteen punctures. They have, however, nothing but praise for their auto. Their speed averaged about six miles every hour, which is a record in itself. The car was equipped with new Edison storage battery which held up for a surprisingly long time. According to Brown and Edwards, the voltage was almost half, even after they had reached Baltimore. With this point in mind, it is easily seen that the electric type will be far more successful than the gasoline powered autos.

"In spite of their well earned glory, the two boys are returning to school next Wednesday."

This news flash comes to us out of the kindness of the heart of the History committee of Xi chapter of ΣT.

Does this look like an answer to global problems of ignorance, disease and physical deprivation?

Not yet. But we're getting closer.

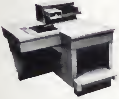
Behind this movement is a simple statistic with startling implications for all of us — *If you count all the scientists and engineers since the beginning of recorded history, ninety percent are alive today!*

We are now in the midst of the result — an incredible explosion of information from every corner of the globe. And somewhere within this explosion will be the ultimate answers to mankind's oldest, and newest problems.

The challenges are many. First, to understand the nature of this giant intellectual force. Then, to find the best way to collect it, classify it, store it . . . and distribute it appropriately and instantly to the people who need it.

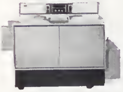
In this light, you might consider today's Xerox products early and primitive steps along a difficult but fascinating path. You'd be right. Yet, has anyone taken these steps before us?

Your degree in Engineering, Science, Business Administration or Liberal Arts can qualify you for some intriguing openings at Xerox, in fundamental and applied research, engineering, manufacturing, marketing/sales, finance and administration. See your Placement Director or write directly to Mr. Stephen G. Crawford, Xerox Corporation, P.O. Box 1540, Rochester, New York 14603. An Equal Opportunity Employer.



The Xerox 914 Copier revolutionized the office copying industry when it was introduced in 1959 . . . and really started us on our way.

Less than 3 years later, the 813 further extended low-cost, quality office copying. One-seventh the volume of the 914, it does just about everything the 914 does except copy solid, 3-dimensional objects.



Another revolution. An electro-mechanical-chemical-optical device called the 2400 because it produces 2,400 copies per hour directly from an original document. No stencil or "master" of any kind. You press a button.

XEROX

TOP PHOTO: LDX (Long Distance Xerography) scans, transmits and reproduces images over distances limited only by the transmission medium. Something like it may print the morning paper at your breakfast table some day, or help you manage a global business.

WELCOME !

It is the purpose of these writings to welcome this year's new students to the school of Engineering and Applied Science. While a personal welcome is extended of course, it is our intention here to welcome you to the professional study of engineering.

The School of Engineering is a professional school in a University which has a liberal arts college, a law school and a medical school among others. The University is the only private, non-sectarian institution of higher learning in the Nation's Capital.

What faces the student of engineering and applied science here at the George Washington University, and his life's work as an engineer? We hope to provide at least a partial answer as we seek to help you know what the study of engineering and science offers, what the differences are, what study in an engineering school such as The George Washington University's is like and then specifically what our purposes are, and how we approach the education of the engineer-applied scientist.

TODAY AS BEFORE

Engineers today, just as in the past, are engaged in the design and construction of bridges, tunnels, automobiles, aircraft, electrical and electronic systems and devices, to mention only several examples out of a myriad that exist. All of these projects, systems, construction, design, manufacture and fabrication are intended to improve and to preserve our way of life. A new factor has been added, however, which has a strong influence on what the engineer does and how he does it. We may call this factor the explosion of technology". What this really means is that the engineering applications of new scientific information, principles and theories that have been discovered, have acquired enormous potential for practical use and widespread applications in many areas. The realization of this potential is the domain of the engineer. The engineer can no longer design an airplane, a missile or a bridge using old methods, formulae, and even old materials, and feel that he is doing the best job possible. The door has been opened to an enormous amount of knowledge. Who can say, even today what the full potentials are of the laser, atomic energy, computers, titanium, cryogenics, and space travel? The application of principles, theories, new techniques, new devices, new forms of energy may be called "applied science". It is applied science which attempts to meet the urgent demands for putting these new tools to work for the earliest possible use by society. To meet this demand, an increasing number of engineers are engaged in research a[nd] development, which is really a general term describing what happens when an effort is made to take a basic principle, convert it to a first principle and convey it to a first model for productio[n].

There are strong bonds between engineering and science.

The primary job assignments of all technical efforts may be classified as basic research, applied research, design and development, applications engineering, production or construction, service and operation, and administration. This is a wide spectrum of activity and requires the scientist, engineer, technician as a team. Between 15% to 20% of all engineers are employed in applied research. The largest single group of engineers work in design and development. The next largest groups are involved in applications engineering and production/construction. Applications engineering may be a new term for the reader. An applications engineer prepares the plans and designs for using a product to meet a specific need. A jet engine company's application engineer may work closely with an aircraft manufacturer who requires such engines as power plants in his aircraft.

Does this mean that at The George Washington University we do not reach electrical engineering, civil engineering, mechanical engineering, etc.? We do but, as in all modern schools of engineering we must attempt to prepare the student for the real world in which changes are taking place rapidly. We must emphasize the art and science of engineering.

MORE ENGINEERS . . .

Since an engineering education should prepare people for potential service in the wide spectrum of activity we have mentioned, most engineering schools aim their course programs somewhere between the applied research and design functions. The unique characteristic of an education in engineering today is the preparation of the individual for analysis, synthesis, and design of technical systems through a well-founded problem solving approach. Approximately 900,000 engineers are employed today in our country in industry, government, private research institutions and universities, according to the Bureau of Labor Statistics. Scientists number about 200,000. There is a good reason why there are more engineers than scientists. Industries have found there is a greater number of job functions which can best be filled by persons with an education in engineering.

Engineering is a professional field and anyone who desires to enter service in such a field

must have the appropriate specialized training. Additionally, it is important that he know something of our cultural heritage and the world in which he works and lives through study of the liberal arts and humanities. Engineering and liberal arts are not opposed, they are complementary. Furthermore, one's learning only begins in college. Throughout one's life there are many opportunities to learn, to gain familiarity with the many facets of our society, its government, its operations, its mores and customs and the issues which face our people.

What is the program of study in a school of engineering such as The George Washington University? The basics are (1) the pure science and mathematics, the physics, chemistry and calculus, (2) the applied science, such as electromagnetic wave theory, control theory, fluid mechanics, earth science, thermodynamics, astronomy, analytical mechanics, engineering materials, operations research and structural theory, (3) the engineering such as hydraulic engineering, structural design, reactor engineering, regional and urban planning, engineering electronics, computer and electrical laboratories, transducer and digital computer techniques, and (4) the general liberal arts studies.

MENTAL DISCIPLINE

The basic preparation in science and mathematics followed by courses in applied science and technology impose a discipline upon the engineering student which many other students in other areas of learning do not share. You have probably heard that the undergraduate engineers, as a group, work the hardest on campus. This is not because the courses an engineering student takes are, in themselves, more difficult than those taken by liberal arts students. The intellectual discipline or training of mind a student receives in engineering requires industry, but not a complete sacrifice of time. Disciplined mental activity is required in any study of professional areas. Good study habits, a capacity or determination for sustained application, a desire to accomplish your goals and ability to concentrate and to organize your work, are all essential qualities. Make an orderly approach to problem solving and persist in the face of difficulty. The effective management of time is basic. Does this mean there can be nothing but a steady, study grind? Many students have not found it so. The fact that an engineering student may find it necessary to put forth more effort makes the success all the sweeter.


Assistant Dean Herbert E. Smith

SUCCESS

Success in engineering depends on your interest, enthusiasm, and motivation. Motivation depends to a large degree on a student's development. Lack of ability is seldom a reason for failure. Lack of motivation and failure to understand what engineering is, are causes for failure. Without these factors, the disciplined study will not come early. The requisite intelligence and good accomplishment in high school go a long way to determining fitness for engineering study, as well as study in many other fields. A famous American once said that the perpetually condemned man is one who does not make use of his talents whatever they are. The mind is not a storehouse to be filled by professors, but an instrument to be used. You determine your success more than anyone else. It is indispensable quality. Thomas Edison, for example, did not enter his laboratory and invent the electric light bulb. He did so only after repeated failures on which he capitalized. The only discouraging thing about failure is not making the most of it by profiting from understanding why the failure occurred.

It is our purpose in the School to assist you in any way we can with all our resources to help you to success. Those of us who have practiced engineering know how rewarding an experience it can be. In my case, it has brought me all over the world in many interesting and challenging projects. The experience in dealing with creative people has been a most satisfying life's work. We welcome you to your preparation for such work. That the School will have a part in shaping your future is a responsibility that we do not take lightly. We earnestly hope that you will recognize your responsibilities, develop as rapidly as you can, and fulfill your objectives.

ON THE DE-SPINNIN

by Douglas L. Jones

INTRODUCTION

Virtually all satellites are spin-stabilized during the phase of operation which places them in orbit. This means that during launch the satellites and carrier rockets are spun at several hundred revolutions per minute around the axis of symmetry. In this manner the small directional errors in rocket thrust are averaged to zero and also the satellite will not tumble if it is spinning around its axis of symmetry.

However, after the satellite is placed in its proper orbit it is usually necessary to de-spin it to a relatively low spin rate or even to zero. This is usually done to permit the proper functioning of the experiments in the satellite. Thus, it is necessary to consider methods of de-spinning the satellite to a desired final value.

There are several de-spinning techniques which are currently in use. One of the more important techniques is the use of retro-rockets. These rockets are placed in such a position that when they are fired the spin momentum is reduced by a specified amount. This is an effective method but it requires rather elaborate instrumentation to obtain accurate control of the final spin rate.

The spin rate is often reduced significantly by increasing the spin moment of inertia. Since the angular momentum remains nearly constant, an increase in moment of inertia induces a decrease in the spin rate. Since many appendages are utilized on satellites, i.e. solar paddles, antennae, etc., this method is effective but allows little flexibility in obtaining desired final spin rates. Actually this method is not used for the purpose of obtaining desired final spin rates but the spin reduction must be taken into consideration.

Another particularly effective method of spin reduction is a momentum exchange device known as a yo-yo de-spin mechanism. This method employs a pair of weights wrapped around the body of the satellite which are released and allowed to unwind. As the weights unwind they gain angular momentum and are finally released when the wire is perpendicular to the satellite. Two weights are used so that no unbalanced forces are applied to the center of mass of the satellite and the only effect will be that of decreasing the spin. It is the purpose of this paper to analytically determine the equations of motion of the satellite and to determine the final spin rate given the initial conditions and parameters of the problem.

There are two distinct phases of the spin reduction process. Phase 1 describes the period when the wire is tangent to the satellite and is unwinding from it. Phase 2 describes the period of constant wire length when the angle changes from the tangent to the perpendicular position and is released.

PHASE 1 ANALYSIS

The configuration described by the Phase 1 analysis, together with its coordinate system, is shown in Figure 1. Only one wire is shown since the system is considered to be symmetrical about the spin axis. We make the following assumptions: (1) all other forces can be neglected, (2) the system can be treated as a free body since the resultant force on an orbiting body is approximately zero, and (3) the weights of the wires will be neglected.

The Lagrangian of the system, which in this case is the total kinetic energy, is

$$L = \tfrac{1}{2} I \dot{\phi}^2 + \tfrac{m}{2}(\dot{x}^2 + \dot{y}^2), \tag{1}$$

where m is the total mass of both weights, I is the moment of inertia of the satellite about the spin axis, and $\dot{\phi}$ is the spin rate of the satellite. Using the transformation equations

$$x = a\cos\theta + \ell\sin\theta, \tag{2}$$

$$y = a\sin\theta - \ell\cos\theta, \tag{3}$$

the Lagrangian may be written in the form

$$L = \tfrac{1}{2} I \dot{\phi}^2 + \tfrac{m}{2}\left(\ell^2\dot{\theta}^2 + a^2\dot{\phi}^2\right). \tag{4}$$

From geometric considerations the length of wire unwound at any time during this phase is

$$\ell = a(\theta - \phi). \tag{5}$$

Lagrange's equations of motion in the generalized coordinates θ and ϕ are

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\phi}}\right) - \frac{\partial L}{\partial \phi} = Q_\phi = 0, \tag{6}$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}}\right) - \frac{\partial L}{\partial \theta} = Q_\theta = 0. \tag{7}$$

Equations (5), (6), and (7) can be integrated to yield an equation which expresses the conservation of momentum. Equation (4), which by being constant represents the conservation of energy, can be combined with the conservation of momen-

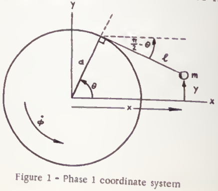


Figure 1 - Phase 1 coordinate system

F SATELLITES

Douglas L. Jones is a full-time graduote student working for o D.Sc. in Mechanics. This is his second yeor as NASA Predoctoral trainee. Three yeors ogo, Doug was editor of Mecheleciv while finishing his undergraduate work here.

tum equation to yield $\dot\phi$ and $\dot\theta$ as a function of the length of wire, ℓ. Thus

$$\dot\phi = \frac{\dot\phi_0(1-\ell^2/\lambda^2)}{1+\ell^2/\lambda^2} \tag{8}$$

and

$$\dot\theta = \frac{2\dot\phi_0}{1+\ell^2/\lambda^2}\ , \tag{9}$$

where $\dot\phi_0$ is the initial spin rate and $\lambda^2 = I/m + a^2$. The above mentioned equations can also be integrated to give the length of wire as a function of time.

$$\ell(t) = a\dot\phi_0 t\ . \tag{10}$$

If it is desired the spin rate $\dot\phi$ can be written as an explicit function of time by substituting equation (10) into equation (8).

PHASE 2 ANALYSIS

A sketch of the configuration for phase 2 is shown in Figure 2. The Lagrangian in this phase is given as

$$L = \frac{1}{2}I\dot\phi^2 + \frac{m}{2}\left[a^2\dot\phi^2 + 2a\ell\cos(\theta-\gamma)\dot\phi\dot\gamma + \ell^2\dot\gamma^2\right] \tag{11}$$

where $\dot\theta = \dot\phi$ since ℓ is constant. Analysis of this phase is considerably more difficult than for Phase 1 but the spin rate at the end of Phase 2, $\dot\phi_2$, can be determined since $\theta - \gamma = 0$ at that point.

The conservation of energy at $\theta - \gamma = 0$ yields the equation

$$\frac{1}{2}I\dot\phi_2^2 + \frac{m}{2}(a\dot\phi_2 + \ell\dot\gamma)^2 = \frac{1}{2}(I+ma^2)\dot\phi_0^2 \tag{12}$$

and the conservation of momentum yields

$$I\dot\phi_2 + m(\ell+a)(a\dot\phi_2 + \ell\dot\gamma) = (I+ma^2)\dot\phi_0\ . \tag{13}$$

Combining equations (12) and (13) gives

$$\frac{\ell}{a} + 1 = \frac{(1-\Omega)I}{ma^2} + 1 \Big/ \left[\frac{(1-\Omega^2)I}{ma^2} + 1\right], \tag{14}$$

which yields upon rearranging

$$\Omega = \frac{(G+1)^2}{(\ell/a+1)^2 G} - \frac{G+1}{G}\ , \tag{15}$$

where $\Omega = \dot\phi_2/\dot\phi_0$ $\qquad G = \frac{(1-\Omega)I}{ma^2}$

for conciseness of notation.

Equation (15) is an exact representation since no approximations have been made but the expression is too complicated for easy manipulation. Therefore, considerable simplification can be achieved by noting that G is large for most practical despinning problems. Thus G can be replaced by G + 1 in the denominator which yields

$$\Omega = \frac{G+1}{(\ell/a+1)^2} - 1\ . \tag{16}$$

Now, if ℓ/a is greater than 2π, which is usually the case, equation (16) may be put in the simple dimensionless form

$$\frac{I}{m(a+\ell)^2} = \frac{1+\Omega}{1-\Omega} \tag{17}$$

which allows the final spin to be evaluated without any great difficulty.

CONCLUSIONS

Equations (8) and (17) give the spin rates during Phase 1 and at the end of Phase 1 respectively. This information is adequate for proper determination of despin weights and wire length if the other input parameters are known. Therefore, any desired final spin rate can be obtained with the proper weights and wire length. If the information is desired, the tension in the wires can be determined by a similar analysis.

A refinement of the yo-yo despin mechanism has been recently introduced which uses a spring rather than a wire for the mechanism. Called a stretch yo-yo, this device compensates for errors in initial spin rates or changes in the moment of inertia. If the initial spin is greater than expected, the yo-yo spring will expand causing a greater reduction and thus decreasing the final error. This appears to be a very useful device if the final spin rate is critical.

For certain other applications another variation of the yo-yo mechanism is one called a yo tumbling mechanism. This device uses only one despin weight usually attached a certain distance from the center of mass. A yo system can cause a body to despin and at the same time impart a tumbling or coning motion to the body. This has been used on final stages of rockets and also on sounding rockets to introduce a desired change of motion. The same general analysis employed for the yo-yo mechanism is applicable to the stretch yo-yo and yo systems. Of course, some modifications in the analysis are necessary before the system can be described accurately.

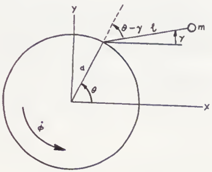


Figure 2 - Phase 2 coordinate system

CAMPUS NEWS

TAU BETA PI

The Tau Beta Pi Association, national engineering honor society, was founded at Lehigh University in 1885 by Edward Higginson Williams, Jr., "to mark in a fitting manner those who have conferred honor upon their Alma Mater by distinguishing scholarship and exemplary character as undergraduates in engineering, or by their attainments as alumni in the field of engineering, and to foster a spirit of liberal culture in the engineering colleges of America.

—Preamble to the Constitution.

On February 16, 1963, the District of Columbia Gamma Chapter of The Tau Beta Pi Association was installed at The George Washington University School of Engineering and Applied Science. This culminated a three-year effort by the local engineering honor society, Sigma Epsilon, to establish a Tau Beta Pi Chapter on campus.

MEMBERSHIP REQUIREMENTS

Candidates eligible for election to membership fall into four general categories:

1. Undergraduate students meeting the scholastic requirements.
2. Alumni of the college whose chapter may consider them, who met the scholastic requirements as undergraduates.
3. Alumni of a college other than the one whose chapter may consider them, who met the scholastic requirements as undergraduates.
4. Engineers of high attainment in the profession, regardless of college attended, undergraduate scholastic record, or educational background.

Undergraduate students must stand in the top eighth of their class in their next-to-last year or the top fifth of their class in their last college year to be eligible for consideration. A quota limitation is placed on the number of first term "junior" electees; these electees are designated Honor Students. The remainder of the top eighth of the "junior" class is eligible for election in their second semester or second or third quarter.

Elections and initiations by the undergraduate chapters are normally held twice a year, in the fall and winter or spring terms of their institutions.

Membership in Tau Beta Pi is limited to men, although women are eligible under the same rules for award of the Women's Badge.

In addition, Tau Beta Pi has required that each undergraduate student elected to membership write an essay, preferably on a non-technical subject, and containing from 500 to 1,500 words, for submission to his chapter. These papers, traditionally called pledge essays, have been judged by the chapter, and the winner in each competition has been awarded a prize. The prize has long been paid for, under one plan or another, by the national organization. After several earlier trials, a national competition for the chapter-winning papers in each fall and spring election class was instituted by the 1950 Convention, with the judging done by a committee of alumni recommended by the Alumni Representative and with cash prizes, ranging up to $100 plus a certificate, for the best essays.

THETA TAU

"Whatsoever thy hand findeth to do, do it with thy might."

Theta Tau is a national professional engineering fraternity. The fraternity was founded at the University of Minnesota in 1904. Gamma Beta Chapter was inaugurated at The George Washington University on March 15, 1935 by the late Dr. Norman B. Ames. In memory of Deacon Ames, a most coveted award is made by the chapter each year to the engineering student most outstanding in Engineering School activities.

The purpose of Theta Tau is to promote a high standard of professional interest among student engineers, and to unite them in a strong bond of fraternal fellowship. As such, Theta Tau does not rival social fraternities, nor are membership requirements such that it competes with, or serves as, an academic honor society. The fraternity thus provides a middle road for friendly association with men of the same chosen profession. Membership itself is extended by invitation to those students who have successfully completed at least the freshman year, and who have no less than six months remaining prior to graduation. These students should have demonstrated themselves to be sociable and practical, and displayed an interest in fraternal ideals.

Gamma Beta Chapter of Theta Tau sponsors various activities for its members throughout the year. Among these are the fall and spring banquet and ball, fall shrimp feast, Christmas party, Memorial Day picnic, and brother-pledge mixers. The fraternity continues its activities during the summer with crab feasts and ocean beach trips. Since Theta Tau does not wish to overburden engineering students with social activities, it schedules less than twelve events per year. This keeps cost per member within reason, yet allows ample time for the development of fraternal friendships.

Graduation was only the beginning of Jim Brown's education

Because he joined Western Electric

Jim Brown, Northwestern University, '62, came with Western Electric because he had heard about the Company's concern for the continued development of its engineers after college graduation.

Jim has his degree in industrial engineering and is continuing to learn and grow in professional stature through Western Electric's Graduate Engineering Training Program. The objectives and educational philosophy of this Program are in the best of academic traditions, designed for both experienced and new engineers.

Like other Western Electric engineers, Jim started out in this Program with a six-week course to help in the transition from the classroom to industry. Since then, Jim Brown has continued to take courses that will help him keep up with the newest engineering techniques in communications.

This training, together with formal college engineering studies, has given Jim the ability to develop his talents to the fullest extent. His present responsibilities include the solution of engineering problems in the manufacture of moly-permalloy core rings, a component used to improve the quality of voice transmission.

If you set the highest standards for yourself, enjoy a challenge, and have the qualifications we're looking for — we want to talk to you! Opportunities exist now for electrical, mechanical and industrial engineers, and for physical science, liberal arts and business majors. For more information, get your copy of the Western Electric Career Opportunities booklet from your Placement Officer. And be sure to arrange for an interview when the Bell System recruiting team visits your campus.

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MECH MISS . . .

SALLY ANNE STOOPS

Miss October is Sally Anne Stoops, a Saphamore transfer student from Sweetbrier College. This 18 year ald, five faat three, brown eyed beauty is majoring in Mathematical Statistics, af all things. When she's not distributing Poissons, Sally enjays drama singing and playing the piano. Cammuting from Annapalis every day and pledging Kappa Alpha Theta help to keep this talented yaung lady out of toa much mischief.

It's abvious that this manth's rallying cry is, "Sally Stoaps to canquer."

MEET THE CLASS OF '65

They're members of Bethlehem Steel's 1965 Loop Course — graduates of colleges and universities from coast to coast.

What is the Loop Course? Since 1922, Bethlehem has conducted this Course for training college graduates for careers in Bethlehem's management. Hundreds of men at all levels of Bethlehem management, including our Chairman, started their careers as loopers.

The '65 Loop convened at our general offices in Bethlehem, Pa., early in July. After five weeks of thorough indoctrination, many of these men were assigned to facilities throughout the country for further brief training at the operations before undertaking their first job assignments. Others, such as sales and accounting trainees, may remain at the general offices for some months before being assigned.

Most Loopers Have Technical Degrees

Our primary need is for engineering and other technical graduates. Such men have many fine opportunities in all phases of steelmaking, as well as in research, sales, mining, fabricated steel construction, and shipbuilding. Also, both technical and non-technical graduates are needed for other important activities including accounting, sales, purchasing, traffic, finance and law, industrial and public relations, and general services.

You'll find a great deal more information in our booklet, "Careers with Bethlehem Steel and the Loop Course." You can obtain a copy at your Placement Office, or drop a postcard to Personnel Division, Industrial and Public Relations Department, Bethlehem, Pa. 18016.

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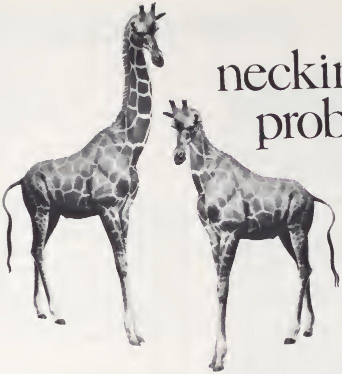

necking problem

To build a rectangular color TV tube with more of a picture than the earlier round tube type, and then squeeze it into a dimensionally attractive cabinet—you face almost insurmountable challenges.

Just to build a conventional color tube, you must . . .

1.—with absolute precision, lay more than a million red, blue, and green phosphor dots in a perfect triad pattern over the entire surface of the picture screen. Why so tough?—because the light source for the dots is a single ray coming through a pinhole. And it must be bent by a correction lens with precise mathematical calculation (different for each dot) to pass through over a third-of-a-million pinholes and fall exactly at a given spot on the screen.

2.—Once you've figured out the phosphor dots, you must then bend the electron beam broadcast by the TV station so that it too passes through the third-of-a-million pinholes.

These are just some of the feats you must perform. But after going through all this, you wind up with a tube with a neck so long it requires a cabinet nearly a yard deep to hold it. To shorten the neck requires mathematical calculations and engineering techniques so demanding they fall beyond any brief description.

The complexity of the 23-inch rectangular color tube development is considered by some of our consumer products engineers even more of a technological challenge than designing some of the sophisticated command systems required for space flights.

Motorola military engineers tend to disagree.

But now that we've brought it up, Motorola has accomplished both.

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MOTOROLA

HOW TO SUCCEED IN SCHOOL

Lee Kaminetzky graduated first in his class at G.W.U., with a BSE in Math, in 1963. He received his MS in Math at N.Y.U. in Feb. of 1965 and is now married, teaching at C.C.N.Y. and studying for his doctorate at N.Y.U.

This article is reprinted from the March 1963 issue of Mecheleciv in the interest of higher learning.

by Lee Kaminetzky

Engineering problems are unique in that quite often the answers are provided, at least implicitly, with the questions. The student, in an attempt to obtain the required solutions, will frequently resort to somewhat non-rigorous, if not incorrect, mathematical devices. There is sound reasoning behind such tactics, however. In general, engineering students cannot correctly solve problems posed by textbooks or by instructors: a natural immunity exists. But because these students are collectively more brilliant than their non-engineering counterparts and also, it goes without saying, the entire Engineering School faculty, various non-rigorous techniques may be employed to arrive at the desired solutions with a minimum of effort on the student's behalf and a maximum of confusion on the instructor's behalf. This is the desired end.

The engineering student, bright as he is, may still wonder why he can utilize irregular methods and not be penalized. He will reason that the members of the faculty are not as ignorant as they outwardly appear to be, and that some may even have attended college for a short period of time where they, too, were trained in the art of fallacious reasoning.

The answer to the above inquiry is quite simple. First, instructors, by nature, do not retain anything they have learned for any measurable length of time, hence any techniques they may have been introduced to in their past are long forgotten. Second, success in the use of non-rigorous mathematics is heavily dependent upon external factors—how busy the instructor is, how long the particular assignment is, how well camouflaged the techniques are, how disarranged the student's paper is, and the like. The inherently lazy instructor will usually check only the answer in a homework paper, reasoning that a correct answer implies a correct method of attack. Good for him! Also, if the assignment or examination is lengthy, or if the instructor has little time to grade papers, he will tend to skim over minor points. Good for him! If the student's paper has enough wrinkles, erasures, arrows, cross-references, etc., the instructor will not try to understand everything on the paper because of the sheer complexity of the organization of the paper. Good for him!

Every student develops his own methods of conveying to instructors the apparent wealth of knowledge possessed in each course. Below, some of the more well known devices are presented for contemplation. The student should realize that principles are being illustrated, even though the mathematics is glaringly incorrect. It is the responsibility of the student to employ the techniques discreetly and in a manner which will bring credit and honor to himself and his fellows.

The first method is of relatively modern origin, but it is more of a desperation maneuver than anything else. The object is to take the derivative of a constant and to arrive at an answer different from zero. In the fierce fury of examinations or in huge homework assignments, this small error may easily be overlooked if done in a very non-chalant manner. Here is a simple example:

PROBLEM: Prove that, if s=displacement, t=time, and $s = 3t^2 + 4t + 3$, then, velocity at $t = 0$ is 4.

SOLUTION: Velocity is ds/dt. The plan of attack is obvious. One need only differentiate s with respect to t and evaluate the result at $t = 0$. But suppose now the student performs the differentiation with an error and finds that

$$ds/dt = 6t + 4t$$

and at $t = 0$: $ds/dt = 0$ and not 4. Should the student worry? Of course not! He should erase the above computation and mentally proceed as follows:

$$ds/dt = 6t + 4t + d3/dt$$

A quick check shows that $d3/dt = 4$ at $t = 0$ is a sufficient condition to obtain the correct answer. So the student calculates

$$d3/dt \doteq \Delta 3/\Delta t \doteq 4$$

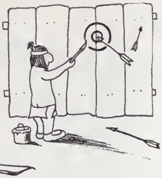
For one place accuracy on a slide rule, the number 3 is really 3 ± 0.5, so $\Delta 3 = +0.5 - (-0.5) = 1.0$. Hence

$$d3/dt \doteq 1.0/\Delta t = 4$$

and so $\Delta t = 1/4$ in the neighborhood of $t = 0$.

All of the above was done mentally or on scratch paper; on the homework assignment or the examination paper, the student places the statement: "In the neighborhood of $t = 0$, the

WITHOUT REALLY TRYING



change in t is 1/4." The instructor will not know where this came from or even what it means, but this is the whole beauty of the art. The student proceeds:

$$ds/dt = 6t + 4t + d3/dt \doteq 10t + \Delta 3/\Delta t$$

$$= 10\,t + 1.0/0.25 = 10\,t + 4$$

The velocity at $t = 0$ is therefore

$$ds/dt = 10(0) + 4 = 4$$

QUOD ERAT DEMONSTRANDUM

The preceding illustration is quite elementary, and most instructors would notice the error and reward the student commeasurably. But as was mentioned above, the object of the example is to illustrate a principle. Suppose the differentiation was performed as part of a problem in circuit analysis, where differential equations are scattered liberally across one's paper. A small aberration in differentiation would surely go unnoticed. Thus this method can be used in principle, if due care is taken to avert emphasis from the calculation in question.

Another important area in which slight errors can benefit students is the field of vector analysis. Quite often if the student is careful to obscure his work, the dot product and cross product can be interchanged at will to provide many fascinating results. It is not often that an instructor will use his precious time to figure out that $\bar{i} \cdot \bar{i}$ is not zero or that $\bar{j} \times \bar{j}$ is not one. The manipulation of unit vectors, as shown, can eliminate unwanted terms whenever such is deemed necessary.

The appearance of a sign opposite to that desired can often be remedied by either of two ways through vector analysis. The earlier of the two is the interchange of terms in a cross product, since $\bar{a} \times \bar{b} = -(\bar{b} \times \bar{a})$. This is done with facility, and many an instructor will not deny the veracity of such formulas as $\bar{M} = \bar{F} \times \bar{r}$ and $\bar{v} = \bar{r} \times \bar{\omega}$, where $\bar{M}$ = moment, $\bar{F}$ = force, $\bar{r}$ = radius vector, $\bar{v}$ = velocity, and $\bar{\omega}$ = angular velocity.

The other means of changing signs is gotten from the use of a pictorial representation of a cartesian coordinate system. Many students are enthralled by the possibilities of using LEFT handed coordinate systems and taking cross products like $\bar{i} \times \bar{j} = \bar{k}$. Not only is this method fun to use, but it has been known to deceive many engineering instructors.

One other point to be made about vector analysis is that the derivative of a unit vector in rectangular coordinates is zero, whereas in cylindrical and spherical coordinates, it is not. If the student must eliminate some terms of an expression, he may successfully escape the scrutiny of the instructor by differentiating non-cartesian unit vectors, obtaining a zero result, and obscuring the calculation.

A favorite means of avoiding responsibility and of diguising lack of knowledge by both students and instructors is the use of some trite phrases like the following: "it is obvious that. . ."; "it is evident that. . ."; "it is self explanatory. . ."; "it is readily seen that. . ."; "it follows. . ."; and "time does not permit derivation, but. . .". These phrases should appear on papers whenever a student does not know what to do, but he vaguely remembers some equations that he has seen. The professor is given the impression that his student has a good knowledge of the course material (for how else would equations be intuitively obvious ?), and everyone is satisfied with the results.

The following "identities" have been used successfully in many varied circumstances:

(1) $(-x)^{1/2} = -(x)^{1/2}$

(2) $(a^2 \pm b^2)^{1/2} = a \pm b$

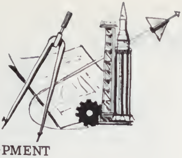
(3) $\log cx = c \log x$

(4) special case: $\log(-x) = -(\log x)$

(5) $\sin 60^\circ = 1/2 \cos 30^\circ$
$\cos 60^\circ = 0.866 = \sin 30^\circ$
$\sin 45^\circ = 1.414 = \cos 45^\circ$

If one is careful in employing the above principles, he will easily succeed in school without really trying.

TECH NEWS



FUEL-CELL DEVELOPMENT

Plans for development of this country's first air-breathing, lightweight fuel-cell system to power forward-area military radios, radars, and other electronic equipment were disclosed recently by the United States Army Electronics Command.

A contract for exploratory and advanced development models of this sophisticated electrical power source has been granted by the Electronics Command to Monsanto Research Corporation, a subsidiary of Monsanto Company.

Fuel cells have no moving parts but generate electricity silently through chemical conversion of fuel. As long as the cells have fuel, they can operate without attention. They have a much higher power-to-weight ratio than other electrical power sources, and since they make no noise they would not attract the attention of an enemy.

The new tactical fuel cell will obtain its oxygen from the air. Its hydrogen will be contained in hydrazine, a liquid fuel that can be handled and transported as is gasoline. The contract calls for both exploratory and development models that will produce 720 watt-hours (60 watts for 12 hours) on a single 2-pound fueling. The final model of the system will weigh 10 pounds and occupy less than one cubic foot of space.

ROCKET HANDGUN

A rocket handgun, claimed to be a revolutionary development in small arms, now is being produced by MB Associates of San Ramon, Calif. The handgun is a lightweight aiming and firing device for a high-velocity, spin-stabilized miniature bullet-shaped rocket that has been trade-named Gyrojet. The propellant is a solid fuel and is ignited by a percussion primer.

When fired, the complete rocket, including the primer, thrusts forward and accelerates rapidly. Nothing is left in the chamber to be ejected as in conventional guns. Total burning time for a typical 13-mm. Gyrojet is about a hundred milliseconds, at which time the projectile is traveling at 1,250 feet a second.

The projectiles are spin-stabilized by canted ports in the aft end. The Gyrojet case and aft-end nozzle are made of high-strength alloys.

Six rounds are spring-fed into firing position through the pistol grip. A unique "forward hammer" drives the projectile back against a fixed firing pin that initiates the percussion primer. The forward thrust of the rocket forces the spring-loaded hammer forward and down to clear the barrel and cock the weapon for the next round.

LOWEST-PRICED IBM COMPUTER ANNOUNCED; WILL ACCEPT PROBLEMS IN ENGINEERS' LANGUAGE

The lowest-priced stored program computer ever marketed by International Business Machines Corporation was announced today. Programmed to "understand" the language of civil engineers, it will lower the cost of bridge and highway design, property subdivision and right-of-way computations.

The new IBM 1130 computing system will rent for as little as $695 a month. Capable of performing 120,000 additions a second, the 1130's internal computing power is greater than that of systems costing several times as much.

IBM will make available without charge a number of programs to assist engineers in making full use of the 1130's problem-solving capabilities.

One will be a version of the civil engineering-oriented COGO (COordinate GeOmetry) program originally developed by Professor Charles L. Miller, head of the department of civil engineering, Massachusetts Institute of Technology. Available for use with an 1130 having disk storage capabilities, COGO enables engineers to state problems in their own professional language, feed them directly to the 1130, and receive immediate answers. Other 1130 programs are for mathematic and statistical calculations. They include programs for matrix inversion, simultaneous equation solution, real and complex roots of polynomials and regression analysis.

A variety of peripheral units enhance the computer's usefulness to engineers. They include the IBM 1627 plotter for on-line mapping, drafting, and plotting; card and paper tape input/output units; and a low-cost printer.

Without a computer language such as COGO, a civil engineer would have to seek the assistance of a trained programmer who would write sequences of coded instructions to tell the computer how to solve the problem. With COGO, an engineer without any programming experience can use an 1130 as he would a slide rule. Simple statements -- outlined for the engineer in a handbook — provide the computer with all it needs to take raw data and perform computations. The engineer himself can enter these statements into the computer through the 1130's console typewriter. He also can have them punched into cards and then entered into the computer.

Several programming systems, including FORTRAN and a monitor program, will be provided with the 1130. The monitor will oversee the running of programs on 1130s with disk storage facilities to ensure efficient system use. Main memory of the 1130 is magnetic core storage with a capacity of either 4,096 or 8,192 16-bit words. Memory cycle time -- the time required to move a word from and restore it to memory — is 3.6 microseconds.

The basic IBM 1130 computing system will rent for $695 a month and sell for $32,280. A typical system with disk storage will rent for $895 a month and will cost $41,280.

First, what is the obvious? It's obvious that you're in demand. You don't have to worry about getting your material wants satisfied. And you don't have to worry about getting opportunities for professional growth.

But, if you look beyond the obvious, you'll realize now that you're going to want something more than material rewards from your career. You're going to want **pride**—pride in your personal, individual contribution.

Melpar is a proud Company. We're proud of our approach to the solution of problems; we're proud of our growth pattern; and we're proud of the communities that surround our laboratories and plants in Northern Virginia.

But most of all, we're proud of our contributions in the areas of basic and applied research, design, development and production in the areas of Advanced Electronics, Aerospace Systems, and the Physical and Life Sciences. Our projects have ranged from tiny microcircuits to computers the size of a basketball court. From synthesis of an insect's nervous system to a study of cometary tails. From production of thousands of high reliability circuit boards for the Minuteman Program to construction of a transmitting antenna atop the Empire State Building.

Look beyond the obvious . . .

Melpar's broad activities have created requirements for engineers and scientists with degrees in Electrical Engineering, Mechanical Engineering, Physics, Chemistry, Mathematics, and the Biological Sciences.

If you want an opportunity to be proud of your contribution and your Company, we're interested in hearing from you. Tell us about yourself. Either ask your Placement Director for more information, or write to our Professional Employment Supervisor. Tell him if you would like to hear from one of your college's graduates who is now progressing at Melpar.

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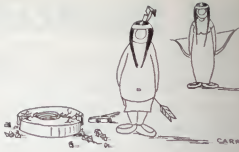
THE

SHAFT



"Wait till you hear!" said one coed to another. "I went to the movies last night and I had to change my seat three times!"

"You mean you were actually molested?"

"Eventually."

* * *

From G.W. comes word of a new student organization called Students Anonymous. If you get a strong desire to study, call them, and they'll send someone over to drink with you.

* * *

"What sort of person is Mrs. Foster, Colonel?" asked a lady of her dinner partner.

"Oh, you know," replied the Colonel, "the sort of a person who calls a table napkin a serviette."

"But I always call it a serviette," said the lady.

"Then," said the Colonel blandly, "you know exactly the kind of a person she is."

* * *

Tact is knowing how far to go in going too far.

* * *

Then there was the engineer who made his own drink at a party. It's called a Gin Daddy. It's made with equal parts of gin, milk, and sugar. It seems that the sugar gives you energy, the milk gives you pep, and the gin gives you ideas of what to do with all your pep and energy.

* * *

A young couple recently moved into an apartment. Finding the place infested with mice, the husband purchased two mousetraps and placed them in the basement. One he put by a basket of apples and another by a box of nuts.

Late that night a loud "snap" was heard and the husband rushed downstairs. His wife followed him to the top of the stairs.

"I got him," yelled the husband.

"Did you catch him by the apples?" queried his wife.

"No dear," he answered.

Two E.E.s were sitting in the library when a young coed walked by.

"Her neck's dirty," said one.

"Her do?"

* * *

That the moon is high, I don't deny.
In fact, I always knew it.
But I do imply it's not as high
As the cost of getting to it.

* * *

The personnel department of a company was giving an applicant one of those intelligence tests, and he was asked to select the one word out of place in this group: Man, woman, eggs, carpet, loving.

As a matter of fact, we didn't know what the correct answer was, but the applicant reasoned thusly:

"Well, you can beat a man, and you can beat a woman, and you can beat eggs, and you can beat a carpet, but you can't beat loving."

* * *

Mother: "Do you like your new nurse, Jimmy?"

Jimmy: "No, I hate her. I'd like to grab her and bite her neck like Daddy does."

* * *

There was the young man who saved for years to buy his mother a house, only to find that the police department wouldn't let her run it.

* * *

"Last night I persuaded my girl to say 'yes.'"

"Congratulations, when's the wedding?"

"What wedding?"

* * *

There's one consolation: If a girl doesn't like her own figure she can always lump it.

* * *

"What are you doing in the cellar, children?"

"Making love," came the reply.

"That's nice. Don't fight."

Love -- the delusion that one woman differs from another.

* * *

It was their first quarrel, and the sordid subject was money.

"Before we were married," she cried bitterly, "you told me you were well off."

"I was," he snarled. "But I didn't know it."

* * *

The old river boat captain was bragging to one of his passengers.

"Yup," he said proudly, "I really know this river like the palm of my hand. There ain't a sand bar on it that I ain't familiar with."

Just then the boat ran aground with a sickening lurch.

"See," he said calmly, "there's one of 'em now."

* * *

Sergeant: "I suppose after you get your discharge, you'll be praying for me to die so you can come and spit on my grave?"

GI: "Not me Sarge. Once I get out of this here army, I ain't never gonna stand in line again!"

* * *

A man in the insane asylum sat fishing over a flower bed. A visitor approached and wishing to be jolly remarked. "How many have you caught?"

"You're the ninth," was the reply."